TECHNICAL MEMO

PREPARED FOR: Morgan City - Ray Little, Jamie Grandpre, Jeff Wardell, Fran Hopkin

PREPARED BY: Gary Vance, P.E.

DATE: August 19, 2015

RE: **Process Upset / Sludge Removal at Lagoons**

BACKGROUND

Lagoon performance has severely deteriorated since late July. Effluent is very turbid, has a sulfurous odor, and does not meet permit requirements. The lagoons have gone septic (no dissolved oxygen) due to a "perfect storm" of conditions, including the following:

- **Excessive sludge buildup** - To our knowledge, the lagoons have not been dredged since they were constructed in 1968. Recent measurements indicate that a significant percentage of the volume in Cells #1 and #2 is occupied by sludge. This excessive sludge buildup has contributed to cause anaerobic conditions in the normally aerobic lagoons. Proper treatment cannot be achieved under anaerobic conditions.
- **Floating duckweed cover** - Floating duckweed mats prevent sunlight from entering the ponds which in turn blocks algae photosynthesis. This reduces dissolved oxygen concentrations and contributes to the ponds going septic. The duckweed mats also reduce the effectiveness of the surface aerators. Eventually the duckweed dies off and generates additional sludge in the bottom of the lagoons.
- **Warm weather** - It is more difficult to keep oxygen in solution when the water temperature is warm. Warm temperatures also contribute to rapid duckweed growth.

It was previously reported that excessive sludge accumulation in the primary cell was a concern and needed to be removed. According to Rural Water, more than 1/3 of the primary cell volume is occupied by sludge. Average sludge depths are estimated to be 3-4 feet deep, with spot measurements of up to 7 feet deep. This reduces the volume available for treatment. In addition, anaerobic digestion of the sludge generates odors and releases accumulated nutrients into the effluent. To optimize performance of the lagoons, this sludge needs to be removed.

In typical lagoon applications, the majority of the suspended solids in the influent settle out in the primary cell. Therefore, most lagoon systems have significantly less sludge accumulation in their subsequent cells. For this reason, Rural Water did not measure the sludge depths in cells

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#2, #3, and #4. However, it has recently been determined that these cells also have significant sludge accumulation, which is contributing to the process upset. AWS Dredging measured the following sludge depths:

Cell	Average Sludge Depth	Maximum Sludge Depth
#1*	3-4 feet	7 feet
#2	3-4 feet	5 feet
#3	~3 feet	5 feet
#4	~2 feet	4 feet

*AWS Dredging measurements are consistent with Rural Water measurements in Cell #1

It is likely that most of the sludge deposition in Cells #2-4 is from duckweed die-off and decay. It was reported by AWS Dredging that the sludge felt different and is less dense than the sludge present in the primary cell.

Due to the combination of excessive sludge accumulation, duckweed mat, and warm weather the lagoons have reached a tipping point. They have gone septic and are no longer functioning as required. The dissolved oxygen concentration in all of the ponds is essentially 0 mg/L which is causing a violation of the permit limit for dissolved oxygen. Effluent nutrient concentrations are higher than influent concentrations due to the release of phosphorus and nitrogen from the sludge blanket under fully anaerobic conditions. BOD removal is less effective under anaerobic conditions so it is anticipated effluent BOD will climb in the near future and also exceed the permit limit. The anaerobic conditions are also generating significant odors.

RECOMMENDATIONS

Representatives from State DWQ (Paul Krauth, Lonnie Shull, and John Cook) were onsite August 19, 2015 to evaluate the process upset. They recommended that the city remove all of the sludge from Cells #1 and #2 and also remove the floating duckweed mat from all of the cells. J-U-B agrees that implementing these recommendations will result in the highest likelihood for lagoon recovery.

Duckweed Removal

It is suggested the duckweed be removed using foam swimming noodles tied together with a cable. Use trucks to guide the duckweed mat to the corner of each lagoon cell and remove the duckweed using a vactor truck.

Sludge Removal and Disposal

It is recommended that accumulated sludge be removed from Cells #1 and #2. The lagoon ponds can stay in service during sludge removal. There are three alternatives for sludge disposal, as described below. The cost opinions shown below are order of magnitude estimates based on preliminary information. These are subject to change as further details are gathered. We are also waiting for AWS Dredging to provide formal quotes for their services and costs may be adjusted at that time.

- **Land application of 3-6% solids, straight from the lagoons.** Spread dredged sludge on land using a tanker truck. The biosolids need to be tilled into the soil at the end of each day. Cannot land apply while ground is frozen or covered in snow. Acreage depends on nutrient concentrations in sludge and nutrient uptake of crop. AWS Dredging initially estimated 200 acres and 1,000 tanker loads would be required. It is not acceptable to pump directly to the fields as the application rate needs to be uniform and closely monitored. Sludge sampling results and land application calculations need to be submitted to DWQ prior to application. **Estimated cost greater than $500,000.**

- **Pump sludge from lagoons to Geotubes for dewatering and sludge conditioning.** Each 60'x200' Geotube can hold 1,100 cubic yards of material at a solids concentration of 10-12% (polymer is injected to thicken the solids). It is estimated approximately 6 to 8 Geotubes would be required to store the sludge from Cells #1 and #2 and these would be located in Cell #5. A HDPE liner would need to be installed below the Geotubes to contain the 'filtrate' which would then be pumped back to the lagoons. After a minimum 6 weeks of drying, the solids can be land applied using a manure spreader. Sludge sampling results and land application calculations need to be submitted to DWQ prior to application. The sludge must be tilled into the soil at the end of each application day. The city can wait and land apply at a future time if that is more convenient. The solids concentration out of a Geotube can be as high as 22%. **Estimated cost greater than $500,000.**

- **Improve unused Cell #6 and pump sludge from Cells #1 and #2 into this cell.** First remove all trees and shrubs from the lagoon including stump and root removal. Raise berm (about 3-4ft) on three sides of cell to match that of other cells. Grade lagoon and install HDPE liner. Pump sludge from Cells #1 and #2 and inject polymer to increase solids concentration but do not use Geotubes. Engineering drawings and a construction permit are required for the Cell #6 improvements. Decant liquid from sludge storage lagoon to Cell #3 to aid the drying process. It is anticipated the sludge will be dry enough to land apply in 3-5 years. **Estimated cost approximately $250,000 - $400,000, including Cell #6 improvements.**

<u>Basis for Cost Opinions (all numbers are approximate and need to be verified)</u>

- Sludge pumping costs: $100,000 - $150,000 (assume $4,000/day)

- Clearing/grubbing: $16,000 (quote from Wardell Bros)

- Earthwork / raising dikes: $40,000 - $60,000 (estimated 5,000 CY of native material, will cost more if imported materials are required). Actual volume will be calculated using survey data. Includes base prep and grading.

- Liner: \$70,000 - \$110,000 (estimated 110,000 sf of liner required. JUB rule of thumb based on past projects is \$1/sf. I also spoke to directly to Northwest Liners and they quoted \$0.90/sf for installed liners. These are for 60 mL HDPE liners which are the industry standard. NW Liners estimated \$0.75/sf for 40 mL liner and ~\$0.35/sf for 10 mL which essentially would be a throw away liner and will be destroyed when you start mucking out the lagoon in a few years. I spoke to John Cook and Dan Griffin at the state to determine what type of liner they would require. They were going to get together with their groundwater experts and discuss. There's a chance they may allow a bentonite clay liner which would be less expensive. However, clay liners are labor intensive to install and could push the schedule back into the winter months.

- Soil Cap: \$40,000 - \$60,000 (estimated 4,000 CY for 6" sandy material, orange construction fence layer, and 6" of additional material). The purpose of the soil cap is to protect the liner so it is not destroyed while cleaning out cell. The liner manufactured recommended 12" of sandy material over top of the liner. Alternative materials may be considered. Additional sandy material may be required below the liner if the subgrade is not smooth.

The recommended alternative is to utilize the currently unused Cell #6 for sludge storage and dispose of the sludge once it dries several years from now. It should be noted that it will be difficult to evenly dry this amount of sludge. It may need to be turned occasionally and there is a chance it will generate odors.

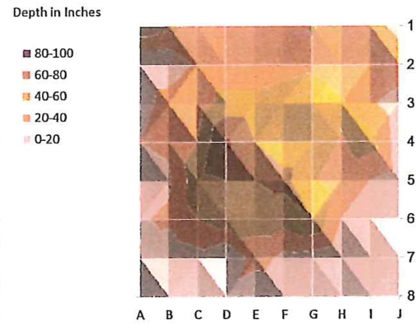
NEXT STEPS

Please let us know which way you would like to proceed and we will move forward ASAP. This work is being performed under a separate time and materials job number. An Authorization for Additional Services was provided to Jamie Grandpre on August 17, 2015.

Morgan Pond 1

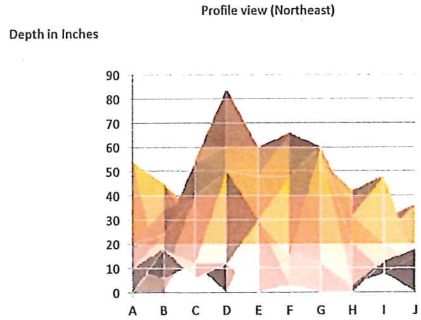
Morgan Pond 1

Plan view



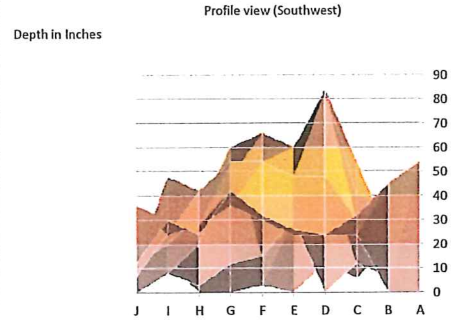
Morgan Pond 1

Profile view (Northeast)



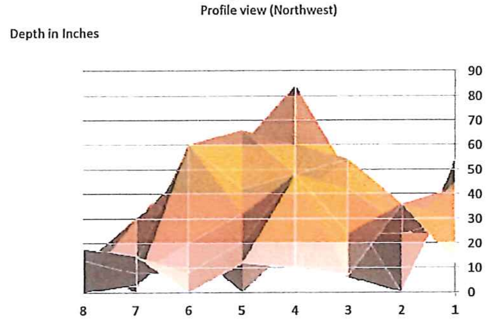
Morgan Pond 1

Profile view (Southwest)



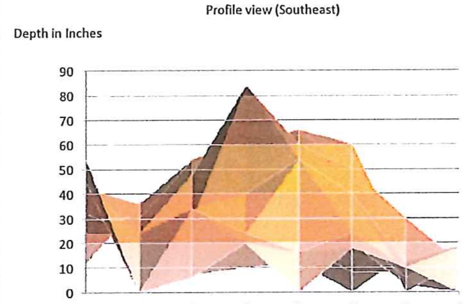
Morgan Pond 1

Profile view (Northwest)



Morgan Pond 1

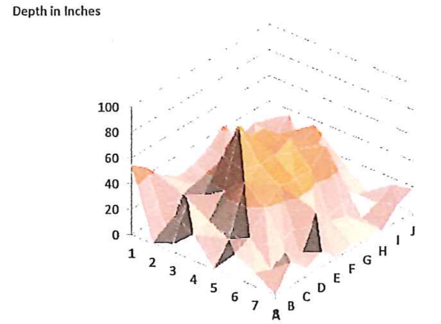
Profile view (Southeast)



Morgan Pond 1

Morgan Pond 1

Profile view (Northeast)



Morgan Pond 1

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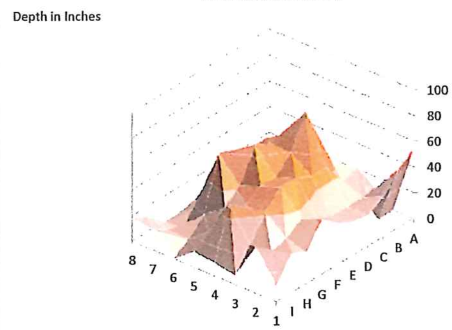
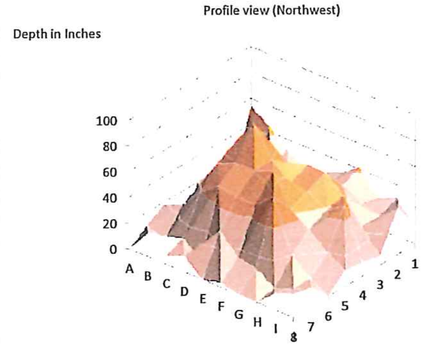
Profile view (Southwest)



Morgan Pond 1

Morgan Pond 1

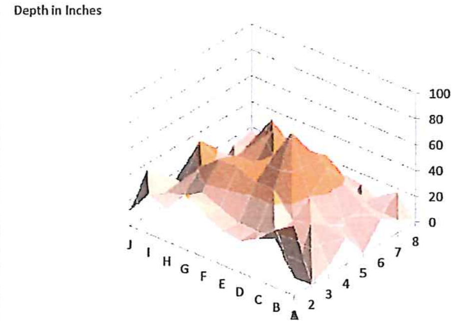
Profile view (Northwest)



Morgan Pond 1

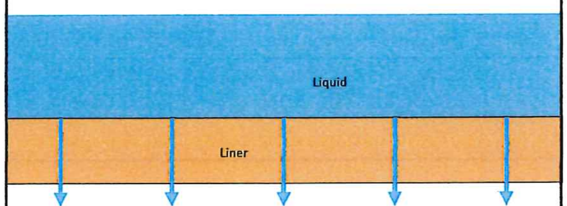
Morgan Pond 1

Profile view (Southeast)

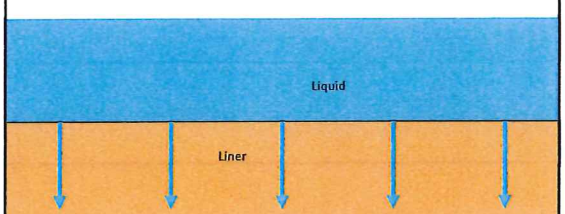


Soil Liner Laws

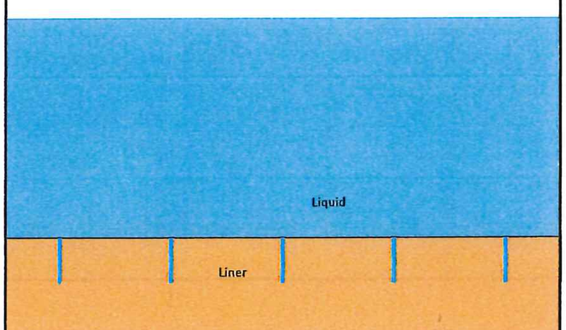
- ✓ Seepage is a function of liner thickness
- ✓ Thicker liner gives lower seepage rates
- ✓ Seepage rate is a function of liquid depth
- ✓ Deeper depth gives higher seepage rates



Seepage Rate



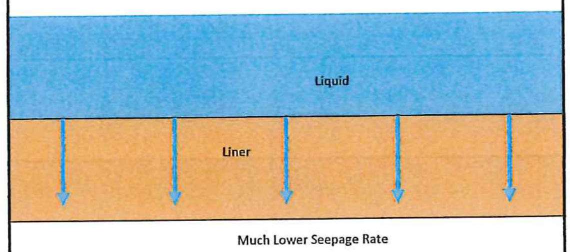
Lower Seepage Rate

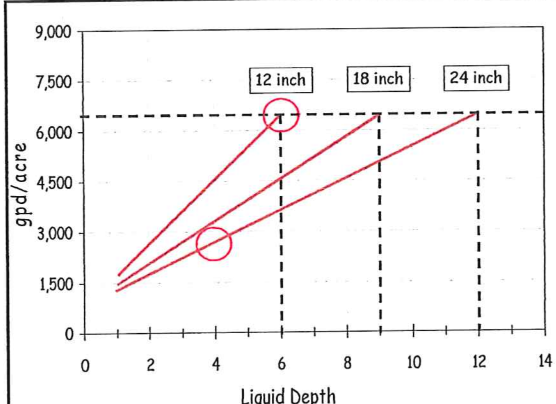


Higher Seepage Rate

Morgan Pond 1

- ✓ 9.3 acres primary
- ✓ Average sludge depth ≈ 27.2 inches
- ✓ 918,245 cubic feet
- ✓ 6,868,500 gallons
- ✓ 1,430 tons!
- ✓ 480 ten wheel dump trucks 





Morgan Pond 1

- ✓ 9.3 acres primary
- ✓ @ 6,500 gpd/acre ≈ 60,450 gpd seepage
- ✓ @ 1,900 gpd/acre ≈ 17,670 gpd seepage
- ✓ Loss of approximately 42,780 gpd

August 25, 2015

Jamie Grandpre
Wastewater Senior Operator
90 Young Street
Moran, UT 84050

Re: Pond Dredging

Mr. Grandpre,

AWS Dredge LLC. (AWS) is presenting this proposal to assist with the sludge removal from the wastewater cells 1 and 2 at the Morgan wastewater treatment plant. We are presenting the option we discussed earlier this week – horizontal auger dredging and thickening with polymer and discharge into an open lagoon cell that will be provided.

Approach

We plan to hydraulically dredge and polymerize the biosolids before open discharge into the open cell on the west end of the plant. We plan on using one (1) horizontal auger dredge on cable harness systems to excavate the soft sludge from the pond. We will pump the slurry through a polymer-mixing unit prior to open discharge into an open lagoon cell provided by the City.

We feel very confident in our ability to dredge this pond with very good production. We are assuming about 15,000 cubic yards of biosolids in place. We anticipate removal of 9,200,000 gallons of sludge. This will be measured with an in-line flow meter and will be the basis for payment.

We are not able to pump large amounts of gravel or hard-cemented layers. Our survey indicates that we will dredge soft sludge. We anticipate continuously returning approximately +60% of the water used in this process back into the ponds in the form of clean filtrate.

AWS understands that the City of Morgan will provide the following:

- 110v for polymer injection system
- Potable water for polymer make down
- A discharge lagoon ready and permitted for sludge placement
- Provide sufficient make up water to keep the dredge in production

Project Cost

Our cost for this project is presented as mobilization/demobilization fees and a cost per gallon dredged as measured by the flow meters. The cost is comprehensive covering per diem, dredge, work truck, labor, materials & supplies as well as all set up and tear down time.

Mobilization costs for each phase will be billed upon arrival. All invoices must be paid within 30 days of invoice date or a finance charge of 1.5% per month will be added to the account. A typical dredge day will yield approximately seven hours of dredging production. Cost to stand down $950/day for debris, plant shut downs, or other circumstances outside the control of AWS.

- Mobilization/Demobilization Cost $15,100.00
- Cell 1 dredging and polymer addition $.019 per gallon
- Mob into cell 2 $5,000.00
- Cell 2 dredging and polymer addition $.019 per gallon

Total estimated gallon in each pond is 9.2 million gallons. If both ponds were dredge, the estimated total cost would be $368,700.00.

We estimate that each cell will take about 30 working days to complete. We have based volume estimates on information given to us by the City. AWS assumes that these volumes are accurate and that material located in pond will respond well to hydraulic dredge excavation and effectively move through pipeline.

Based upon the need to provide this proposal as quickly as possible, AWS has not got final polymer numbers for this project. We are assuming that we will use less than 7,500 pounds of polymer per cell. If additional polymer is required to complete the project, the polymer will be charged at $3.00 per pound used.

Schedule

Upon proposal acceptance, AWS will schedule a project start date with the City of Morgan. For this project format AWS will typically work six days a week 10 hours per day. Shift hours may vary. All work will be completed as soon as possible. Debris or other project irregularities may also delay target dates.

Regards,

Mike Scharp
VP Marketing
AWS Dredge

Assumptions

- This is not a squeegee clean cleanout; angles of repose will have material along with corners and toe of slope. There will be an average of one foot of sludge left in the lagoons after dredging is complete so no liner damage will occur.
- AWS assumes that minimal foreign debris exists throughout the pond, and that our pumps will not be hitting and damaged or jamming regularly with non-slurry material including weeds and wood. If we have debris clogging pumps and valves we will charge $250 per occurrence.
- AWS assumes open and free access to the site to work sunrise to sunset seven days a week if required.
- If suspension of work without notification to AWS to manage operations scheduling, AWS reserves the right to charge a stand by rate $950/day.
- AWS will be able to remove the bulk of the material from the pond. Sidewalls, corners, and areas of pond bottom may have material remaining.
- AWS has no responsibility for managing the ponds we are pumping. We assume that there will be enough working water to perform the dredging.
- AWS has assumed good weather and good access to the site. If the weather becomes too wet our completion times could be impacted.
- AWS has not profiled this pond. We have based volume estimates on information given to us. AWS assumes that these volumes are accurate and that material located in pond will respond well to dredge excavation and effectively move through pipeline
- AWS assumes that there will be sufficient make up water in the pond to support dredging operations throughout the course of the project. Should makeup water within the pond become insufficient and force AWS to stand down stand by rate ($950/day) may apply
- AWS assumes that there are no hardened or cemented layers in the pond that we will not be able to dredge through.
- AWS assumes that the City will provide 110volt power to run polymer-mixing equipment.
- AWS assumes that the City will provide a decant cell that is fully operational upon our arrival that is capable of holding the volume of sludge dredged into it.
- AWS assumes no liability for the biosolids either in the current lagoon or once it is dredged into the holding cell or the integrity of the holding cell.